What is claimed:

Sub a1

1. A process for carrying out the water-gas shift reaction, comprising employing a low-pyrophoricity water-gas shift reaction catalyst; wherein the low-pyrophoricity water-gas shift reaction catalyst comprises a solid high heat capacity particulate support impregnated with:

(i) a reducible metal oxide and

(ii) a catalytic agent.

2. The process of claim 1, wherein the water-gas shift reaction catalyst comprises not more than 50% by weight of the reducible metal oxide.

3. The process of claim 2, wherein the reducible metal oxide is in the range of 0.5-35% by weight.

4. The process of claim 1, wherein the particulate support is a high strength support in a durable and rigid form.

5. The process of claim 4, wherein the particulate support is activated alumina.

6. The process of claim 5, wherein the activated alumina has a BET effective surface area of at least 10 m^2/g.

7. The process of claim 1, wherein the reducible metal oxide comprises one or more of the oxides of Cr, V, Mo, Nd, Pr, Ti, Fe, Ni, Mn, Co, or Ce.

8. The process of claim 7, wherein the reducible metal oxide comprises one or more of the oxides of Ce, Cr, Fe, or Mn.

9. The process of claim 1, wherein the reducible metal oxide consists of the oxides of Ce.

10. The process of claim 1, wherein the catalytic agent comprises one or more of Pt, Pd, Cu, Fe, Rh, or Au or an oxide thereof.

SUB a1

11. The process of claim 10, wherein the catalytic agent is Cu or an oxide thereof.

12. The process of claim 11, wherein the high heat capacity support comprises alumina particles with a mesh size of 12 or greater.

13. The process of claim 12, wherein the reducible metal oxide consists of the the oxides of Cr and Ce.

14. The process of claim 12, wherein the reducible metal oxide consists of the oxides of Cr.

15. The process of claim 12, wherein the reducible metal oxide consists of the oxides of Ce.

16. The process of claim 11, wherein copper or an oxide thereof is in the range of 4-20% by weight, calculated as CuO.

17. The process of claim 10, wherein the catalytic agent is Pt or an oxide thereof.

18. The process of claim 17, wherein the particulate support comprises alumina particles with a mesh size of 12 or greater.

19. The process of claim 18, wherein the reducible metal oxide consists of the oxides of Ce.

20. The process of claim 1, wherein the low-pyrophoricity water-gas shift reaction catalyst comprises (i) alumina support particles with a mesh size of 12 or greater and a BET surface area of at least 10 m^2/g, (ii) up to 25% by weight of an oxide of Ce, calculated as CeO_2, impregnated in the support particles, and (iii) between 4 and 14% by

weight catalytic agent wherein the catalytic agent is Cu or an oxide thereof, calculated as CuO; and

wherein the process for carrying out the water-gas shift reaction comprises the steps of:

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a) providing an input gas stream comprising carbon monoxide and water vapor;

b) contacting the input gas stream with the low-pyrophoricity water-gas shift reaction catalyst; and

c) catalyzing the water-gas shift reaction with the low-pyrophoricity water-gas shift reaction catalyst;

wherein the input gas stream includes:

(i) between about 1% by volume and about 10% by volume CO,

(ii) at least 10% by volume hydrogen, and

(iii) at least 10% by volume H_2O; and

wherein the input gas stream is characterized by a space velocity and wherein the space velocity is at least 500 hr^{-1} VHSV.

21. The process of claim 1, wherein the low-pyrophoricity water-gas shift reaction catalyst comprises (i) alumina support particles with a mesh size of 12 or greater and a BET surface area of at least 10 m^2/g, (ii) up to 15% by weight of an oxide of chromium, calculated as Cr_2O_3, impregnated in the support particles; and (iii) between 4 and 14% by weight catalytic agent, wherein the catalytic agent is copper or an oxide thereof, calculated as CuO; and

wherein the process for carrying out the water-gas shift reaction comprises the steps of:

a) providing an input gas stream comprising carbon monoxide and water vapor;

b) contacting the input gas stream with the low-pyrophoricity water-gas shift reaction catalyst; and

c) catalyzing the water-gas shift reaction with the low-pyrophoricity water-gas shift reaction catalyst;

wherein the input gas stream includes:

(i) between about 1% by volume and about 10% by volume CO,

(ii) at least 10% by volume hydrogen, and

(iii) at least 10% by volume H_2O; and

wherein the input gas stream is characterized by a space velocity and wherein the space velocity is at least 500 hr^{-1} VHSV.

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22. The process of claim 1, wherein the low-pyrophoricity water-gas shift reaction catalyst comprises (i) alumina support particles with a mesh size of 12 or greater and a BET surface area of at least 10 m^2/g, (ii) up to 25% by weight of an oxide of cerium, calculated as CeO_2 impregnated in the support particles; (iii) up to 10% by weight of an oxide of chromium, calculated as Cr_2O_3, impregnated in the support particles; and (iv) between 4 and 14% by weight catalytic agent, wherein the catalytic agent is copper or an oxide thereof, calculated as CuO; and

wherein the process for carrying out the water-gas shift reaction comprises the steps of:

a) providing an input gas stream comprising carbon monoxide and water vapor;

b) contacting the input gas stream with the low-pyrophoricity water-gas shift reaction catalyst; and

c) catalyzing the water-gas shift reaction with the low-pyrophoricity water-gas shift reaction catalyst;

wherein the input gas stream includes:

(i) between about 1% by volume and about 10% by volume CO,

(ii) at least 10% by volume hydrogen, and

(iii) at least 10% by volume H_2O; and

wherein the input gas stream is characterized by a space velocity and wherein the space velocity is at least 500 hr^{-1} VHSV.

23. The process of claim 1, wherein the catalyst comprises (i) alumina support particles with a mesh size of 12 or greater and a BET surface area of at least 10 m^2/g, (ii) up to 25% by weight of an oxide of cerium, calculated as CeO_2, impregnated in the alumina support particles; and (iii) between 0.1 and 1.0% by weight of a catalytic agent wherein the catalytic agent is Pt or an oxide thereof, calculated as Pt;

wherein the process for carrying out the water-gas shift reaction comprises the steps of:

a) providing an input gas stream comprising carbon monoxide and water vapor;

b) contacting the input gas stream with the low-pyrophoricity water-gas shift reaction catalyst; and

c) catalyzing the water-gas shift reaction with the low-pyrophoricity water-gas shift reaction catalyst;

wherein the input gas stream includes:

(i) between about 0.1% by volume and about 5% by volume CO,

(ii) at least 10% by volume hydrogen, and

(iii) at least 10% by volume H_2O; wherein the input gas stream is characterized by a space velocity; and

wherein the space velocity is at least 500 hr^{-1} VHSV.

Sub B

24. An apparatus for carrying out the water-gas shift reaction, the apparatus comprising a low-pyrophoricity water-gas shift reaction catalyst; wherein the low-pyrophoricity water-gas shift reaction catalyst comprises a durable, high heat capacity particulate support impregnated with:

(i) less than 50% by weight of an oxide of Ce, calculated as CeO_2; and

(ii) a catalytically effective amount of a catalytic agent; and

wherein the particulate support comprises alumina particles with a mesh size of 12 or greater.

25. The apparatus of claim 24, wherein the particulate support is activated alumina with a BET effective surface area of at least 10 m^2/g.

26. The apparatus of claim 24, wherein the catalytic agent comprises one or more of Pt, Pd, Cu, Fe, Rh, Au or an oxide thereof.

27. The apparatus of claim 24, wherein the low-pyrophoricity water-gas shift reaction catalyst comprises (i) alumina support particles with a mesh size of 12 or greater and a BET surface area of at least 10 m^2/g, (ii) up to 25% by weight of an oxide of cerium, calculated as CeO_2, impregnated in the support particles ; and (iii) between 4 and 14% by weight catalytic agent wherein the catalytic agent is copper or an oxide thereof, calculated as CuO; and

wherein an input gas stream contacts the low-pyrophoricity water-gas shift reaction catalyst;

wherein the input gas stream includes: (i) between about 1% by volume and about 10% by volume CO, (ii) at least 10% by volume hydrogen, and (iii) at least 10% by volume H_2O; wherein the input gas stream is characterized by a space velocity and wherein the space velocity is at least 500 hr-1 VHSV.

28. The apparatus of claim 24, wherein the low-pyrophoricity water-gas shift reaction catalyst comprises (i) alumina support particles with a mesh size of 12 or greater and a BET surface area of at least 10 m^2/g, (ii) up to 15% by weight of an oxide of chromium, calculated as Cr_2O_3, impregnated in the support particles; and (iii) between 4 and 14% by weight catalytic agent wherein the catalytic agent is copper or an oxide thereof, calculated as CuO; and

wherein an input gas stream contacts the low-pyrophoricity water-gas shift reaction catalyst;

wherein the input gas stream includes: (i) between about 1% by volume and about 10% by volume CO, (ii) at least 10% by volume hydrogen, and (iii) at least 10% by volume H_2O; wherein the input gas stream is characterized by a space velocity and wherein the space velocity is at least 500 hr^{-1} VHSV.

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29. The apparatus of claim 24, wherein the low-pyrophoricity water-gas shift reaction catalyst comprises (i) alumina support particles with a mesh size of 12 or greater and a BET surface area of at least 10 m^2/g, (ii) up to 25% by weight of an oxide of cerium, calculated as CeO_2 impregnated in the support particles; (iii) up to 10 % by weight of an oxide of chromium, calculated as Cr_2O_3, impregnated in the support particles; and (iv) between 4 and 14% by weight catalytic agent, wherein the catalytic agent is copper or an oxide thereof, calculated as CuO; and

wherein an input gas stream contacts the low-pyrophoricity water-gas shift reaction catalyst;

wherein the input gas stream includes: (i) between about 1% by volume and about 10% by volume CO, (ii) at least 10% by volume hydrogen, and (iii) at least 10% by volume H_2O; wherein the input gas stream is characterized by a space velocity and wherein the space velocity is at least 500 hr^{-1} VHSV.

30. The apparatus of claim 24, wherein the low-pyrophoricity water-gas shift reaction catalyst comprises (i) alumina support particles with a mesh size of 12 or greater and a BET surface area of at least 10 m^2/g, (ii) up to 25% by weight of an oxide of cerium, calculated as CeO_2, impregnated in the alumina support particles; and (iii) between 0.1 and 1.0% catalytic agent wherein the catalytic agent is Pt or an oxide thereof, calculated as Pt; and

wherein an input gas stream contacts the low-pyrophoricity water-gas shift reaction catalyst;

wherein the input gas stream includes: (i) between about 0.1% by volume and about 5% by volume CO, (ii) at least 10% by volume hydrogen, and (iii) at least 10% by volume H_2O; wherein the input gas stream is characterized by a space velocity and wherein the space velocity is at least 500 hr^{-1} VHSV.

31. A low-pyrophoricity water-gas shift reaction catalyst, comprising high heat capacity support particles of a mesh size of 12 or greater impregnated with:

(i) a reducible metal oxide; and

(ii) a catalytic agent.

32. The low-pyrophoricity water-gas shift reaction catalyst of claim 31, wherein the reducible metal oxide comprises one or more of the oxides of Cr, V, Mo, Nd, Pr, Ti, Fe, Ni, Mn, Co, or Ce.

33. The low-pyrophoricity water-gas shift reaction catalyst of claim 32, wherein the high heat capacity support particles are activated alumina.

34. The low-pyrophoricity water-gas shift reaction catalyst of claim 33, wherein the catalytic agent is Cu or an oxide thereof.

35. The low-pyrophoricity water-gas shift reaction catalyst of claim 34, wherein the reducible metal oxide consists of the oxides of Ce.

36. The low-pyrophoricity water-gas shift reaction catalyst of claim 34, wherein the reducible metal oxide consists of the oxides of Cr.

37. The low-pyrophoricity water-gas shift reaction catalyst of claim 34, wherein the reducible metal oxide consists of the oxides of Cr and Ce.

38. The low-pyrophoricity water-gas shift reaction catalyst of claim 34, wherein the catalytic agent is in the range of 4-20% by weight, calculated as CuO.

39. The low-pyrophoricity water-gas shift catalyst of claim 31, wherein the reducible metal oxide is in the range of 0.5-35% by weight.

40. The low-pyrophoricity water-gas shift reaction catalyst of claim 33, wherein the catalytic agent is Pt or an oxide thereof.

41. The low-pyrophoricity water-gas shift reaction catalyst of claim 40, wherein the reducible metal oxide consists of the oxides of Ce.

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